UNIVERSITY OF TORONTO

MEDICAL JOURNAL

PHYSICAL ANTHROPOLOGY

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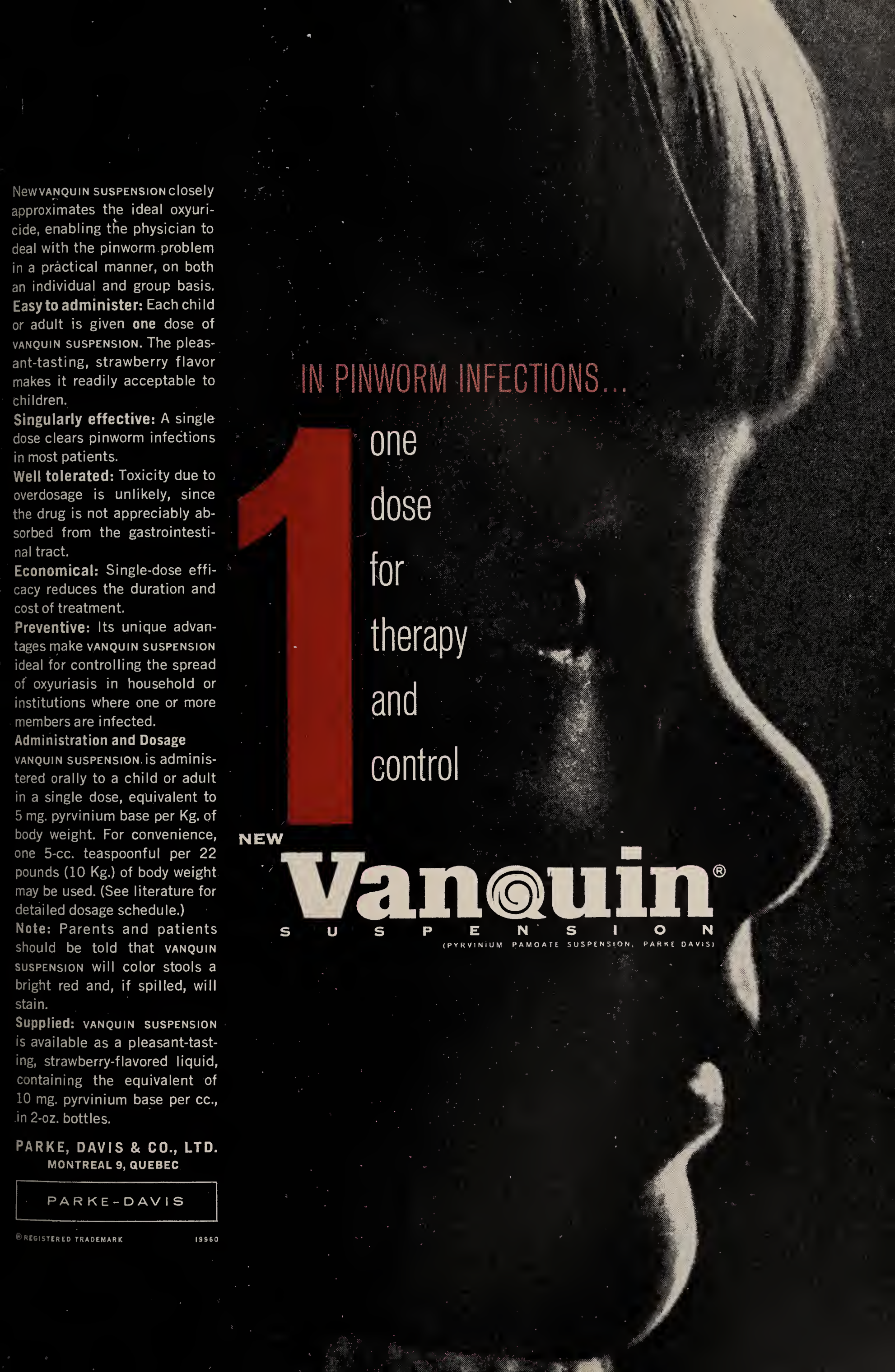

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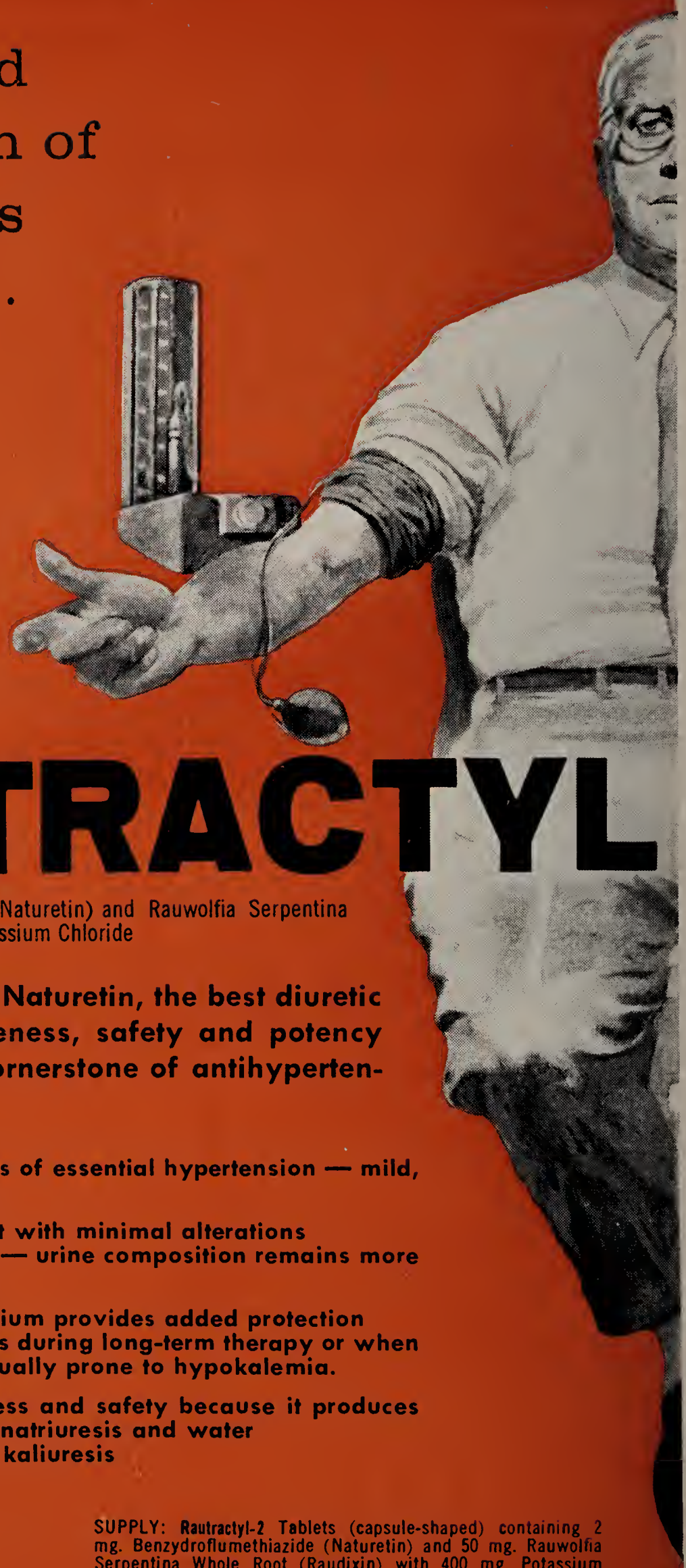

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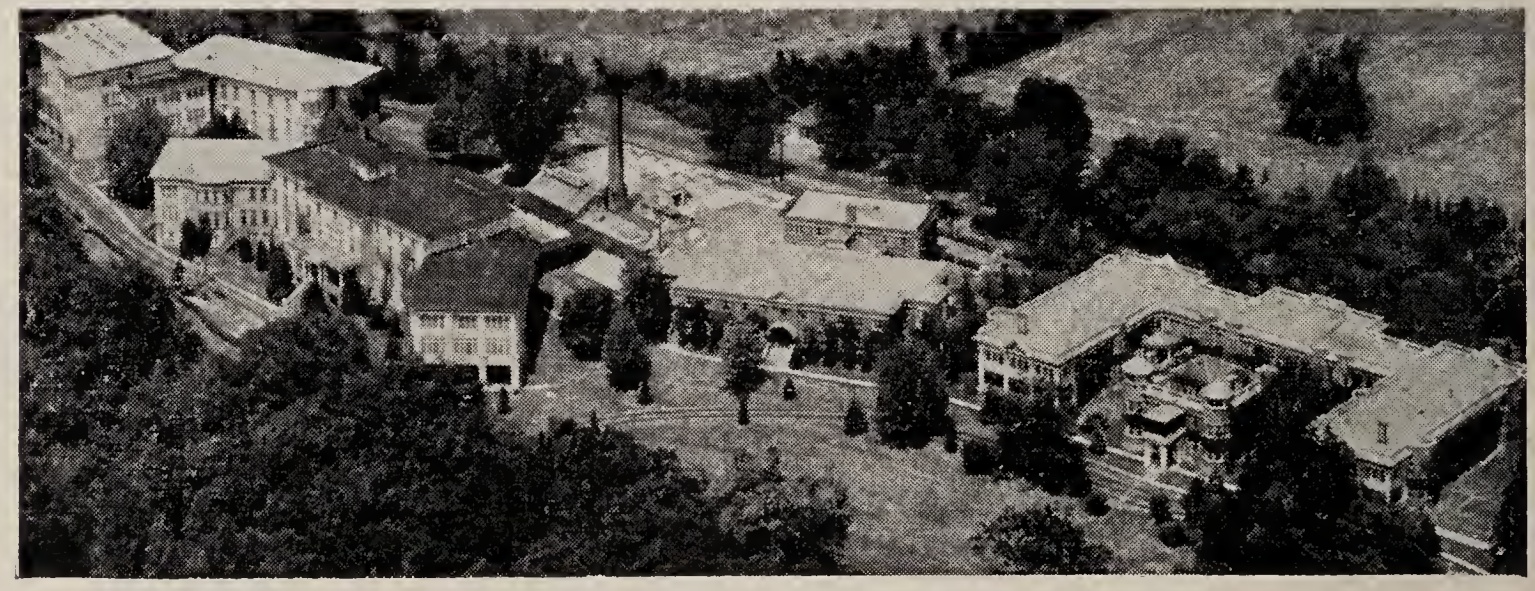

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EDITORIAL

To Work Or Not To Work

Near the end of the third medical year one looks back and can recall seventeen summers of pleasure or toil or a mixture of both. In any event these were summers free of the burdensome yoke of homework, assignments and impending tests; we remember the peculiar significance of the last day of final examinations as the most joyful of the whole year for it is on this day that the next year's exams seem farthest away. The summer after the third medical year presents a problem to most students—should they enjoy their last free summer and have a true holiday or should they take a job in a hospital and gain what seems at the time to be invaluable experience? Let us examine some of the many aspects of this problem.

Most advocates of the four-month summer holiday give as their prime reason the possibility of earning a large sum of money which many students find necessary. For these people the choice is not difficult, for most of the high-paying hospital or laboratory jobs are tedious and uninteresting.

For those who do not need to earn a great deal of money during the summer there is a variety of positions and opportunities available. There are rotating interneships for those who want experience in medicine, surgery, obstetrics and gynecology and the emergency department at large teaching hospitals in the United States and in smaller hospitals in Canada. In the former, one can participate in the teaching programs and make use of the vast amount of available clinical material. Interneships at the smaller Canadian hospitals offer a lesser wealth of clinical material but they give more responsibility which is the most effective stimulus for learning—it is learning out of necessity. There are some mission-type appointments where the third-year student is the doctor for an out-lying community and the responsibility is almost unlimited. For those contemplating one of the specialties there are many excellent opportunities available, in psychiatry at hospitals in Canada, United States and Great Britain and in pediatrics at some of the children's hospitals.

The various appointments are widespread geographically—from California to Finland. The chance to travel is one that must not be turned down; it is unnecessary to dwell on the value of travel except to say that it is refreshing and provides unlimited opportunities to broaden one's experience of life.

Another important opportunity that this last summer affords the medical student is the chance to do research. The trend in progressive medical schools is to foster undergraduate research; thus many openings are and will be available. These positions are not of the usual technical nature, i.e. washing test-tubes and feeding animals; they are a combination of original experimentation, statistical analysis and honest thinking under highly competent guidance. This offers a satisfying and interesting summer of academic value, free of the long hours of strenuous labour put in by most internes.

The value of interneships of a purely clinical nature has been rather nebulous but it is quite clear to us that they are valuable. The older clinicians seem to be in accord when they advise you to get out and have a holiday because it is the last one that you will ever have. However, at the end of the third medical year the student has reached the peak of his undergraduate academic training; he is eager to put it into practice, to test it on fresh clinical material in a setting

where he is doctor and not lowly second-hand medical student. A summer interneship provides this opportunity; consolidation takes place as theory is put into practice under ideal circumstances. It gives the student an ordered way of approaching the patient and his problems and permits him to enter smoothly and quickly into the fourth year, as the train of thought has not been broken by four months of non-medical activity. It shows him how to get the most of his teaching in this year and permits him to take his place naturally on the clinical team.

From this discussion we should draw the following conclusions. Medical summer jobs and interneships are advisable ONLY after the third medical year and are valuable:

(1) because they provide experience which fosters confidence;
(2) because they permit the student to get more benefit from the fourth medical year;
(3) because they may include the opportunity to travel;
(4) because they provide a chance to carry out stimulating and useful research;
(5) because the student may gain experience which will aid him in planning his course after he graduates;

and

(6) if provision is made for a two- to three-week holiday;
(7) if the student does not need to earn his next year's fees.

About This Issue. . . . .

The inspiration and the driving force behind the new department of Physical Anthropology is Dr. J. E. Anderson, the man who has brought new life and vigour into the premedical anthropology course. It is this same person who has been the inspiration and driving force behind this number of the Journal. It is difficult to pay proper tribute to a teacher who has achieved such great success and won so much affection from his students before his star has even gained sight of its zenith.

PHYSICAL ANTHROPOLOGY—A Strange Wedding

J. E. ANDERSON, M.D.*

TO many, it is a strange wedding of anatomy and anthropology that produces the discipline of Physical Anthropology. Indeed, a most varied assortment of people pool their resources to synthesize the story of man: archeologists, linguists, sociologists, paleontologists, psychologists and ethnologists, to name a few.

The study of man's body, which is physical anthropology, has a strong attraction for almost everyone due to the strong curiosity about himself that is a characteristic of man. The form of the human body, when examined, described and considered tells us much: the engineering principles that allow us to function in our environment, the evolutionary transition that points to our origin and suggests our future, the genetic basis of our individuality, and the physical limitations of our nature.

In practice, Physical Anthropology has limited itself to certain fields of investigation: the study of primates and fossil man to learn of evolution; human genetics and environmental influences which enlighten our thinking on the subject of race; the mechanisms of growth and development; the observation of anomalies and variations which show how we vary from each other; and the reconstruction of history by studying the remains of ancient man.

Practical applications of Physical Anthropology include the medico-legal study of the skeleton, counselling in human genetics, the correlation of disease with constitutional types and even the designing of clothing and machinery to fit the human body.

When studying anatomy from a standard textbook, we tend to emphasize the similarities between all of us and overlook how much we differ from each other. We differ in sex, height, build, time and rate of maturation, colour of skin, hair and eyes, resistance to disease, the way we walk and talk, and in our degree of intelligence. When you look about at your colleagues, the variations in head form are striking: long heads and round heads, small noses and large noses, delicate features and rugged jaws. Even the right and left halves of our bodies are asymmetrical. Besides these gross evidences of variation, the delicate branchings of arteries and nerves show almost infinite combinations of patterns, as do the forms and positions of our viscera, the architecture of our bones and the attachments of our muscles. When confronted with this alarmingly diverse structure of mankind, we become more and more reticent to employ the term "normal", because defining the word is as difficult as seeking the pattern that fits it.

Individual variations in appearance, growth, vigour and mentality provide the major limitations of our life situations. These variations are influenced by our racial background, the genetic heritage from our parents, our mother's health and nutrition during pregnancy, the economic background of our family, our diet and health, the climate, the functioning of our endocrine glands. It is humbling to realize how little credit we can take for our own successes.

Many anthropologists have studied the outward form of the body through measurements and qualitative judgments and have defined classifications or somatotypes. The relationship of these body forms to the incidence of disease is the realm of constitutional medicine.

Anomalies are the despair of first year students, the joy of dedicated anatomists and a valuable guide to physical anthropologists. Variations such as the septal aperture of the humerus, os inca in the

*Assistant Professor of Anatomy, University of Toronto.

skull and shovel-shaped incisors occur in definite percentages in different populations. Being part of the skeleton, their relative durability allows us to study their incidence in people long dead and so formulate theories of origin and migrations of peoples.

Paleopathology is the branch of anthropology which deals with disease in ancient man and animals. Study in this field is limited by the sources of material: the skeleton, a few mummies and the portrayal of disease states in primitive art forms such as statuettes. Osteoarthritis, rickets, certain tumours, healed fractures, osteomyelitis, Pott's disease and dental pathology have been observed in ancient skeletons. Correlation of these findings increases our knowledge of the ecology of disease on a longer time scale than is otherwise possible. It is sometimes difficult to achieve personal identification with prehistoric peoples by looking at a few dried bones; the finding of a familiar disease in their remains provides that sympathetic link across the centuries which assists us to understand the culture under scrutiny.

This study of skeletal remains from archeological sites carries with it the intrigue of a good detective story. In reconstructing the crime, the physical anthropologist observes and records in detail burial practices, the vital statistics of the population, genetic and environmental factors reflected in bone changes, and tries to understand how the people looked and in what kind of setting they found themselves.

The 1958 student dig at this university unearthed at Bradford a prehistoric burial ground. At this site two physical types were represented and mutilated burials alternated with carefully interred individuals. Some bones showed signs of violence: depressed fracture of the skull vault, lacerations on bone where limbs were dismembered and a split bone shaft where a projectile point had lodged. A few infant burials were encountered which provided an opportunity to study the form of the juvenile skeleton. From the many observations made and by correlation with the findings at the associated village site, much can be learned about the original citizens of Bradford, Ontario.

At this particular time, the glamour of physical anthropology lies in the field of human paleontology as newer finds of fossil men cast new information on man's origin and evolution. There is an irresistible fascination to the history of the discovery of man's ancestors and collaterals: Davidson Black, the Toronto anatomist who predicted the finding of Pekin Man from the study of a single tooth; the colossal hoodwinking that was Piltdown Man; the strong conviction that led Eugene Dubois to resign his position as an anatomist and go to the Netherlands Indies as an army surgeon where his spare time excavations uncovered Java Man; and Raymond Dart who one afternoon came face-to-face with Australopithecus—a discovery which changed his life and altered our concepts of man's origins.

In Toronto, the co-operation between the Departments of Anatomy and Anthropology has resulted in facilities and opportunities for the study of Physical Anthropology and research into many of its pathways. This issue of the University of Toronto Medical Journal contains a number of papers contributed by students representing the hundreds who have shared in the work.

Appended is a short bibliography covering some of the subjects mentioned in this paper. All are instructive; some are fascinating. I hope you will read a few of them.

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STUDENT ARCHEOLOGY—The Potential Doctor Digs

J. N. EMERSON, M.A., Ph.D.*

THE fall of 1946 was an exciting time for me. It was my first year of teaching, and it was a privilege and a challenge to be teaching Anthropology to the members of the newly-instituted premedical course. The class was largely made up of veterans and this increased the challenge. These men combined a desire for knowledge with a ribald vigor that seldom allowed for a dull moment in the classroom. They worked hard and played hard and they were to leave a profound impression upon the teaching of Anthropology at the University of Toronto.

One fall morning during a premedical lecture in the Economics Building, I was holding forth on the topic of vertebrate evolution and man's vertebrate ancestry when the question was asked, "When do we do some practical work in this subject?" Somewhat taken aback I asked, "What do you mean—hunting for fossils or digging up Indian sites?" The answer was, "Both, I guess." We decided to do something about it.

The first part was easy. We arranged group tours to visit the Don Valley Brick Works where fossils and fossil layers were evident for study and observation. The excavation of an Indian site was a much bigger task!

Because the ground was already frozen and testing for a suitable site or digging was out of the question, we had to wait until spring, but a student committee was formed and plans were laid. I was fortunate that the class president was Lou Quitt, an easy-going, natural-born organizer and leader of men. He laid out a pattern of organization that was to be used for some time.

We selected the "Old Indian Fort Site" near Vandorf for excavation. We scouted and test-pitted it while the snow was still on the ground. Buses were chartered, shovels were borrowed from the city. Dr. Harry Good, now of Haliburton, set up a kitchen in a summer cottage on the property and looked after the great quantities of food and coffee necessary for the noonday meals, including a maple syrup "taffy pull" for the concluding afternoon. Student fliers took aerial pictures of the site.

Kenneth E. Kidd of the Royal Ontario Museum, T. F. McIlwraith of the Department of Anthropology and his assistant, Margaret Thompson, and I took on the nearly impossible task of supervising one hundred students.

We went, we dug, we found not a great deal—we had a wonderful outing and we proved that a student excavation was feasible. We also proved that more detailed planning and a great deal more supervision was necessary.

Fourteen student excavations have now taken place and the Fall student dig has become a part of university life. I will seek here to highlight and evaluate some of the main contributions of this educational experiment begun by the Premedical Class of 5T2.

The archeological results have been widespread and important. The problem and cost of commuting has restricted most of our work to the Metropolitan Toronto area. Here, the selection of sites has been well spaced and systematic: "Black Creek" at Jane and Wilson Avenues (1948), "Downsview" at Jane and Sheppard Avenues (1950), "Parsons" on Finch between Jane and Keele Streets (1952 and 1953), "McKenzie" near Woodbridge (1947 and 1949), and "Barker" north of Pine Grove (1951).

Upon analysis, these sites have been found to represent a series of stages in the northward movement and migrations of Indians who were ultimately to become part of the Huron Nation of the Ontario Iroquois.

*Associate Professor of Anthropology, University of Toronto.

Digging was also carried out in North York and even further north to Haliburton and the Laurentian Shield: Old Indian Fort site (1947); Aurora site (1957); Bosomworth site near Bradford (1958); Shebishekong near Nobel (1955); Benson site near Coboconk (1954). Analysis has shown that the Aurora and Benson sites have late prehistoric and historic connections with the development of Huron, the latter via the Trent Valley. Shebishekong was a beaver hunting station and the Bosomworth site represents a new stage in Iroquois development, yet to be thoroughly understood.

Investigations east of Toronto have revealed the earliest manifestations to date in the valleys of the Rouge and Highland Creek: Thompson site (1956) and Miller site (1959). The Miller village appears to be one of the oldest ancestral Iroquois manifestations in Ontario. The Thompson site may well connect this with villages like Black Creek and Downsview.

Former students now practising medicine may be pleased to note that the work of their spades and trowels is now part of the published prehistory of the Ontario Iroquois.

Each excavation produced its own contribution to our knowledge as well as adding to the broad general archeological picture. Woodbridge has produced the largest and best-documented excavation of an Iroquois longhouse (174′ x 28′) known to date. Black Creek brought to light information on double pallisading. Thompson gave information about the people who left Tabor's Hill Ossuary. Shebishekong brought to light a unique example of Iroquois adjustment to a new ecological environment. Downsview and Barker (with "Heartbreak Ridge") proved that Toronto students can excavate in rain, shine or snow.

What is most important, the principle has been established that learning by doing is an exciting and meaningful kind of learning to which the student responds with enthusiasm. This same approach has brought about the introduction of "bone labs", the analysis of skeletal material from the digs, into the premedical course in Anthropology.

The student digs have also had a social effect upon the learning situation. There have been opportunities for cultivating staff-student understanding. The teacher has had a chance to know the student better and *vice versa*. We found that the experience separated the men from the boys. Those who were good on the end of a shovel or wheelbarrow were usually good in their course work. Those who dug meticulously usually thought in the same organized way. Understanding the material as it came from the ground presented an intellectual challenge over and above the thrill of discovery.

Many students have confided to me that they got to know their fellow students better on a dig than at any social function they attended during their first year. With the extension of the digs to include Arts as well as premedical students more permanent friendships, including interfaculty marriages had their beginnings. I believe that over the years these digs have made a valuable contribution to class spirit and class identification, so necessary in the later medical years.

From a broader, long-term view, a great job of conservation has been done. The McKenzie site is now a housing subdivision, "Seneca Heights". Downsview has also been subdivided, and Black Creek soon will be. Parsons has been cut by the pipeline. Thompson and Parsons are sure to be built upon in the next few years. We can sit back and say that at least the crucial part of their story is safely recovered, thanks to student digs.

Over the years now, some fifteen hundred premedical students have participated in the dig experience. Many are now in practice. Information on sites and archeological finds are being channeled to us from various places indicating that many of the students have cultivated a

lasting interest in the subject of Archeology. I find it a real pleasure now when I travel, to occasionally meet a doctor whom I recognize as having been at Woodbridge in '49 or Barker in '51. We have had the pleasure, too, of having a number of students and graduates spend various periods with us on summer digs.

Over the years these digs have been a wonderful training ground for Anthropology students interested in Archeology as a field of specialty. It is perhaps significant that two of the three Archeologists presently on the Staff of the National Museum of Canada were once students in charge of one of these excavations. This has been one of the greatest honours and one of the greatest responsibilities we can offer in this field.

Student digs at the University of Toronto will probably continue for many years. We in anthropology will always be aware of the debt we owe to the medical class of 5T2 and the succeeding classes who contributed so much to their continuance and success.

Department of Biochemistry Lecture by Dr. C. B. Anfinsen of the National Institute of Health, Bethesda, Md. The topic discussed was "The Study of Structure-Function Relationships in Proteins and its Application to Problems of Evolution". This lecture was held February 3rd in the Medical Building.

The Academy of Medicine held its stated meeting on February 2nd. Dr. E. Richard Harrell of the University of Michigan spoke on "What To Do With A Patient With Xanthomas".

BLOOD GROUPS AND ANTHROPOLOGY—Genes, Bones and Blood

C. PARSONS, 6T4

THE ABO blood group system was discovered by Landsteiner in 1900 and was of immediate interest for transfusion purposes. Until this time, transfusions frequently resulted in agglutination or hemolysis due to the combination of incompatible blood group types. Today, with a more fully developed knowledge of the ABO groups, the Rh factor and several other systems, the transfusion of incompatible blood usually occurs only through error or accident.

Apart from their value in transfusion services, the blood groups since their discovery have been of great assistance and interest to anthropologists.

Blood Groups and Racial Classification

Before the discovery of the blood groups, physical anthropologists relied entirely upon such traits as eye colour, characteristics of the hair, dental patterns, colour of skin and variations in head form to classify the races of living man. It was soon found that blood groups were hereditary and their incidence varied between different populations. As a basis for racial typing, they had the advantages of objective, accurate, easy determination and the data produced was reducible to a statistical form. They seemed to have more significance than morphological traits in that they are less influenced by environmental changes, not subject to a high degree of mutation and each of the many factors is apparently linked to a separate pair of genes.

The two world wars have offered opportunities to accumulate voluminous records of ABO blood groups and to a lesser degree of the other types. Studies of hitherto inaccessible tribes have contributed further to our knowledge of the distribution of the various blood types. From this information, world maps have been drawn and theories have been formulated concerning the origins and migrations of populations.

Mourant (1959) states: "For a time there tended to be two schools of thought among anthropologists, one supporting the blood groupers, and the other the anthropometrists. It is now realized, however, that when the two methods are used with full precautions against both technical and statistical errors they supplement and support one another to a remarkable extent and that both are necessary in order to give the fullest possible information about the relations between populations."

Blood Groups and Disease

In recent years, considerable attention has been directed towards statistical analysis of the relationship of blood types to certain diseases. Reports gathered from many centres show what are believed by some to be highly significant correlations of Group A blood and carcinoma of stomach and uterus. Fairly strong indications also link this type with pernicious anemia and diabetes mellitus. Duodenal ulcer shows a higher incidence in type O patients than in the other groups. Papers supporting these statements have been published by Buckwalter (1956), Clarke (1959) and Roberts (1959). Manuila (1958) and others have attacked these findings on a statistical basis, but the suggestion of correlation is strong and awaits further evidence.

Blood Groups and Prehistory

The study of inheritance of human blood groups is naturally limited by the time required to produce successive living generations. Obviously the anthro-

pological value of blood types would be enhanced if they could be studied on a broadened time scale.

It is now known that blood group substances are present not only in the red blood cell but in certain other tissues of the body including leucocytes, epidermal cells, sperm, the cornea, some cells of the alimentary tract and in bone. This opens up new possibilities in the use of ancient material.

As early as 1933, Boyd and Boyd published promising results of a technique for determining blood groups from mummified tissue and other preserved cadaver material. Chemical and electron microscopic studies have shown the persistence of organic material in bone even after long periods of burial in the ground. Candella, in 1936, reported the blood types of eleven skeletons from Egypt dating from about 1500 B.C. In his technique, anti-A and anti-B sera were titrated against each other so that concentrations of each were obtained which had identical agglutinating strengths. The bone to be tested was ground into a fine powder and samples were incubated at 4°C for 48–72 hours with each of the two prepared sera. During this time, the antigens on the bone adsorbed their corresponding antibodies, thus reducing the agglutinating strength of the serum. After centrifuging, the supernatant serum was reacted with red blood cells of antigen corresponding to the antiserum present. Reduction in titre of the serum was evidenced by its decreased ability to agglutinate red blood cells.

The technical difficulties of such a method are considerable. The sera must be weak enough for adsorption to be noticeable, yet since dry powdered bone adsorbs non-specifically to a variable degree, very weak sera will give false positive readings. The slight differences in skeletal material thus require individual standardization of sera. Another hazard is the long incubation period, since anti-A deteriorates more rapidly than does anti-B serum. Care in preparation of the specimen is also crucial as Wunberg (1959) has shown that the antigen is contained only in cancellous bone.

In this method, diagnosis of type O is unreliable, since it is suggested when, for any reason, there is no antigenic activity. Thieme *et al.* (1956) used anti-O lectins from *Ulex europeus* seeds and found in some cases a change from a diagnosis of type O to type A. Thieme and Otten (1957) carried out tests on bone which had been buried from one to three years in various soils. They found an error of 75 per cent probably due to the action of bacteria in either the specimen or the soil. They also note that accuracy is limited by the presence of many plant and animal substances which closely resemble blood group antigens. It has been found by Gray (1958) that non-specific adsorption can be partially reduced by using a sera diluent rather than saline to maintain antibody activity, using an isotonic phosphate buffer to lower pH variability and washing of samples to remove all soluble foreign matter.

In 1956, Coombs reported a more direct and rapid method for determining the blood type of epithelial cells. It consists basically in reacting the cells for a short time with anti-serum, washing them gently, resuspending them in inactivated rabbit serum, and then placing them in contact with red blood cells of known type. If the epithelial cells being tested are type A, the A antigen attracts and holds some of the anti-A serum, but not the anti-B. Since the antibodies are believed to be at least bivalent, they should be able to form another union with the A antigens on red blood cells. Such a bond is seen microscopically as the red cells cluster and adhere to the epithelial cell.

An adaptation of Coombs' method has been used by Kramer (1957) on samples of dentin from human teeth. In his experiments, blood typing was unsuccessful, suggesting either that blood group antigens are absent in dentin or that this

technique is not applicable to this particular tissue.

Modification of this method for determining the blood type of bone is currently being developed in the Physical Anthropology laboratory at the University of Toronto.

Summary

A brief account has been given of the anthropological interest in blood grouping as a guide to racial classification and its relationship to specific diseases. The current status of the determination of the blood type of bone has been outlined.

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Royal Canadian Institute Lectures: On February 20th Dr. Norma Ford Walker spoke on "New Frontiers In Human Genetics" at Convocation Hall.

Ontario Cancer Institute Seminar on February 10th had as a speaker Dr. F. Karush. He spoke on "Some Physiological Aspects of the Reaction between Antibody and Antigen". Dr. Karush is an eminent immunochemist from the University of Pennsylvania and is noted for his investigations of the antibody-antigen reaction.

ANTHROPOLOGY LOOKS AT AN ANOMALY—Septal Apertures in the Humerus

H. TANZER, 6T4

THE occasional presence of septal apertures in man has attracted attention for more than a century. Michael in 1825 and Broca in 1874 were among the earliest observers. In 1932, Hrdlicka published a careful exposition on septal apertures which rendered a great service by its exhaustive review of the literature, tabulation of distribution in human stocks and by elucidation of the processes possibly responsible for its occurrence.

The aperture in the bony septum of the humerus which separates the coronoid and olecranon fossae has been designated by many names: supratrochlear foramen, introcondylar foramen, olecranon perforation. The terms perforation and foramen are somewhat misleading, since the former suggests traumatic formation and the latter refers to a bony passageway for vessels and nerves. The term best suited for this anomaly is septal aperture.

This paper serves to correlate the findings in the literature with that done by students in anthropology in this University, notably F. R. Bayes, D. Givelas, D. C. McGillivray, F. Rosen and D. Smith.

SEX DISTRIBUTION

The incidence of the aperture is higher in females than in males for all races studied. The ratio is two to one in white races.

SIDE DISTRIBUTION

In almost all series studied, the left humerus has a higher incidence of aperture than the right. Exceptions to this rule were found by Abakori (1934) in Japanese humeri, and Hultkranz (1897) in Swedish humeri. In both of these, the male humeri showed a higher frequency of right perforation than the left. The unilateral occurrences in every case outnumber the bilateral.

RACIAL DISTRIBUTION

The frequency distribution for septal apertures ranges from 4.3% in American whites to 40.4% in Eastern and Arkansas Indians. There is a marked similarity in frequency among peoples of mongoloid stock: 17.5% in Chinese, 22.6% in Eskimos, and 16.9% in Japanese. Groups of the same racial stock, however, may show tremendous variation in the incidence of this anomaly. Abakori (1934) reports on two populations of Ainu with similar environment and mode of life, one with an incidence of 8.8% and the other with 33.1%. This is highly suggestive of a genetic basis.

SIZE AND SHAPE OF APERTURE

The size of the aperture varies from one to twelve millimeters in diameter, with no apparent correlation between age and size of aperture. However, the average size for bilateral apertures is consistently larger than the average size for unilateral ones. The shape is usually ovoid with the long axis in a transverse plane, though sometimes the aperture is circular.

WEIGHT OF HUMERUS

Humeri with apertures tend to be lighter than those without the defect. This has been confirmed here by examination of Iroquois bones. Manouvrier (1921) reports that presence and size of aperture is directly proportional to the weight of the humerus.

Discussion

The presence of septal apertures has been explained as an atavistic character, a mechanical reaction to hyperextension of the elbow, and a result of weak development of bone due to disturbance of

calcium metabolism during the ossification period. There is also the vague idea that the apertures are artefacts produced in ancient bones by weathering and in modern bones by poor skeletonization. We are not concerned with the latter. The true septal aperture when examined closely has smooth edges, whereas those which are a result of trauma are rough and jagged.

THE APERTURE AS AN ATAVISM

The aperture is present in certain mammalian groups which are zoologically widely separated and in general shows a tendency toward obliteration with higher development. It is extremely rare among the New World monkeys; however, among the Old World primates it is constant in the lemur and mandrill.

HYPEREXTENSION OF THE ELBOW JOINT

MacAlister ('00), having found a high incidence in Libyan humeri, attributed the defect to a certain type of work which involved the use of a mattock and consequently to intermittent stress on the elbow joint. Mall ('05) found hyperextension more frequent in female than in male humeri and attributed the higher frequency of apertures in female humeri to this. However, from the assumptions, it does not logically follow that incidence should be higher on the left than on the right side. In fact, since most people are right-handed, the contrary assumption would be more reasonable. Secondly, intermittent pressure (such as produced by working with a mattock) generally causes hyperemia and strengthening of the parts affected rather than absorption which would occur only under constant pressure.

INCOMPLETE OSSIFICATION

The theory which associates light, weak humeri with the presence of apertures, and thick robust bones with the absence of the defect, is entirely in accord with the facts, since right humeri are generally heavier than the left, and male humeri heavier than female. In the case of the Negro bone, which is both heavier and more frequently perforated than the white, the theory might appear inconsistent; but it is not, because Negro bones are heavier due to length and not to robustness.

The most plausible hypothesis to date is that the aperture is a phylogenetic feature inherited in various strengths. This inherent tendency is hindered from manifesting itself in the stronger bone of the stronger individual. This is in accord with the greater incidence on the left side, in the female sex and in certain racial groups to a greater degree than others.

SUMMARY:

The incidence of septal aperture of the humerus ranges from 4.3% in American whites to 40.4% in Eastern North American Indians. There is no correlation between incidence or size with age, but aperture size is always greater in bilateral than in unilateral occurences. Female humeri have a higher incidence than those of males and the anomaly is more frequently found on the left than on the right. It is a genetically determined error of ossification.

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THE MEDICO-LEGAL ROLE OF ANTHROPOLOGY—The Skeleton as a Detective Story

J. D. MARTIN, 6T4

THE physical anthropologist is frequently consulted by legal departments in an effort to identify human skeletal remains. In this role, he deals with that specialized study, forensic medicine. In nearly all criminal and civil court actions it is necessary to establish the identity of the individual. Since, in many cases, little remains of a body other than a few scattered skeletal remains, the advice of the physical anthropologist is often needed. This article outlines some of the information that may be used to identify human skeletal remains.

THE DETERMINATION OF AGE

Useful determinants of skeletal age include fontanelle closure, tooth eruption, order of epiphyseal fusion of the long bones, cranial suture closure and degenerative changes in the skeleton.

The rate of fontanelle closure and deciduous tooth eruption may be used to determine the age of an individual in the first two years of life. The skull contains six fontanelles: the anterior at the junction of the sagittal and coronal sutures, the posterior at the junction of the lambdoidal and sagittal sutures and two pair of lateral fontanelles at pterion and asterion. The two lateral fontanelles close during the first few weeks of postnatal life, the posterior by six months and the anterior by eighteen months.

From the fifth to the fifteenth year, eruption of the permanent dentition, degree of fusion of the occipital elements and union of the epiphyses are the safest criteria. Imrie and Wyburn ('58) state that there is much variation in the order of eruption of teeth, that the onset of puberty greatly affects the eruption time and that there is variation in the patterns of eruption between left and right sides of the upper and lower jaws as well as between the jaws themselves. Tables giving average values of tooth eruption times should be used, therefore, with much caution. Hunt and Gleiser ('55) have concluded that since sex difference in dental maturation is much less than that in the skeleton, the aging of the bone from the teeth can be done fairly accurately without reference to the sexing of the remains. In order to determine the exact age more correctly, it is often necessary to take radiographs of the maxilla and mandible in order to determine the extent of eruption.

The deciduous and permanent dentitions may be seen as rather accurate means of determining age between birth and the seventeenth year, and a more general age indicator between the seventeenth and twenty-fifth years.

It has been found that the rate of epiphyseal union, as an indicator of age, is perhaps one of the most reliable determinants in the first twenty to twenty-five years of life. By noting the appearance of secondary centres of ossification and the rate of fusion of the epiphysis and diaphysis, fairly accurate age determinations are obtained. Growth continues longest at the shoulder, wrist and knee. As a result, these are the last of the long bone epiphyses to fuse. Although the bones of the hand and wrist are good indicators of skeletal age, they are very small and are often lost or destroyed.

The occipital bone is another frequently used age determinant. This bone consists of a squamous, two lateral, and a basilar part. The difference in time of its various suture fusions allows adequate estimation of age. For example, the squamous and the lateral parts unite between the fourth and fifth years, and the basilar and lateral parts in the sixth

and seventh years. The spheno-occipital synchondrosis fuses in the twenty-first year.

To this point we have discussed the means of estimating age in the first twenty-five years. What adequate methods are available after this time? Generally speaking, an age of twenty-five to twenty-eight years may be determined by noting the union of the medial clavicular epiphysis.

The use of cranial suture closure as an indicator of age has been strongly advocated in the past. However, Brooks ('55) found in a study of archeological material that there was a very low correlation between estimations of age based on cranial suture closure and other methods.

A study of degenerative changes in the skeleton is a good method of age determination. Todd ('20) noted predictable changes in the appearance of the symphysis pubis between the ages of eighteen and fifty. These predictions were based on the appearance of the surface and the definitions of its borders. He divided changes in the symphyseal face of the pubis into ten phases, the first three representing two- to three-year spans, the next phases through to phase nine containing five years or more and phase ten including all ages over fifty years. He found that age estimates determined in this manner had high coefficients of correlation with the known age. Further modifications of this method have been attempted by McKern and Stewart ('57). Brooks ('55) noted that age estimation by changes in the pubic symphysis is much more dependable than that derived from cranial suture closure.

Other degenerative changes include observations of the aging process within the teeth such as attrition or wear of the surface, transparency of the root, and formation of the secondary dentine and cementum. As well, studies of joint degeneration and of bony ingrowths into the tendons and ligaments are good general indicators of advancing age.

Of the several indications of age, namely, fontanelle closure, dental eruption, epiphyseal union, spheno-occipital synchondrosis, cranial suture closure and degenerative changes, it cannot be overemphasized that successful age determination of the skeleton depends on the use of not one but a combination of as many of these indicators as possible.

THE DETERMINATION OF SEX

The best and most accurate method of determining sex is by employing the distinguishing features of the pelvis. One criterion is the pubic angle, which is generally over seventy degrees and rounded in the female and less than seventy degrees and more angular in the male. Alice M. Brues ('58) has noted the work of Washburn and Grant in using the pelvis as a means of sexual identification. They note that in the female, the pubic bone is longer in relation to the rest of the pelvis. As well, Washburn ('48) states that the widening of the sciatic notch in the female throws the sacrum back out of the pelvic aperture. This results in a widening of the birth canal in the front to back direction. To give greater emphasis to these observations, Washburn states that the correct sex can be identified in ninety per cent of pelves examined when the relative length of the pubic bone is used as a criterion and in seventy-five per cent of cases in which the width of the sciatic notch is used. The latter observations take into account the race of the skeleton; for in Negroes sex difference is less marked in that both sexes tend toward masculinity. Arthur Thomson defined the essential differences between the male and female pelvis by stating that the male pelvis is a long section of a short cone and the female pelvis a short section of a long cone. The sacrum may be used as a further means of sex identification. In the male, the promontory of the sacrum is wider than each of the alae; in the female, the promontory is

approximately equal in width to each of the alae.

Another useful area for sexual identification is the skull. Generally speaking, the areas of muscle attachment are much more rugged in the male than in the female. This is true not only of the skull, but in all parts of the skeleton. The male skull has a heavier facial region in proportion to the brain case, a heavier jaw relative to the upper part of the face and larger dental arches and teeth. As well, structures which are generally narrower and more sharp-edged in the female are coarser and thicker in the male. The male skull is larger than that of the female, possesses a larger mastoid process and more marked brow ridges.

The long bones of the body may also be used as determinants of sex although less useful than pelvic and cranial criteria. The male bones tend to be heavier and more rugged than those of the female. As well, the joint surfaces are relatively and absolutely greater in the male. Jose Pons ('55), in a study of Portugese subjects, attempted to determine the validity of using certain features of the femur and sternum in indicating the sex of the skeleton. He found that there were discriminant factors allowing the sexual distinction of femora with probabilities of accuracy of ninety-five per cent. In a series of sterna, an accuracy of eighty-nine per cent was obtained.

Alice M. Brues ('58) has noted that sex may be determined fairly accurately from total body height. In a study of American White and Negro subjects she observed that if all subjects over 169 cm. were considered as male, and all those under 169 cm. as female, then sex could be determined accurately in eighty-one per cent of cases.

THE DETERMINATION OF STATURE

Determination of stature from parts of the skeleton is based upon statistical studies which point out the relationship between length of various limb bones and the height of the individual. One such study is that of Trotter and Gleser ('58) which was based on the measurement of American soldiers with well documented physical data.

The problem ultimately arises of determining stature when none of the long bones are discovered intact. In a recent study, the author attempted to determine the stature of a group of Indians using only tarsal bones. The procedure involved finding relationship between the lengths of calcaneum and talus and the long bones of the leg. If a consistent relationship could be found, then the Trotter-Gleser stature tables could be used in determining the height. A fairly consistent relationship was found between the femur and calcaneum in both males and females. Using this ratio it is possible to determine the approximate stature of an individual if only a calcaneum were available.

THE DETERMINATION OF RACE

Living man may be subdivided into main racial stocks which in turn consist of a number of physical subtypes. The assignment to an unknown skeleton of some racial affinity depends on determination of stature, the relative proportions of the body parts, certain characteristics of the skull and the presence of traits reflecting genetic factors influencing the skeleton.

PERSONAL IDENTIFICATION

Estimations of age, sex, stature and racial stock give a very general description of the individual. In certain cases, the anthropologist may be called upon to establish the correct identification of a missing person.

The importance of the teeth as an aid to personal identification is emphasized in a report by R. D. Wyckoff ('57) who

notes the extreme improbability of two individuals having identical dentitions. In many medico-legal cases, checking the missing person's dental records has resulted in positive personal identification.

It is sometimes possible to reconstruct the facial characteristics of an individual from the skull. This study assumes that the skin in certain parts of the face is separated from the bone by a layer of very thin tissue of uniform thickness. In these areas, the living face will resemble the contours of the bones. Such regions include the forehead, the root and bridge of the nose, the accentuated portion of the cheek bone and the lower border of the jaw. Unpredictable areas include the fleshy part of the cheek, the tip of the nose and the lips. An attempt to reconstruct the face of an individual will be very inaccurate if the person possessed marked features that the artist considered as merely average. The best method is to obtain a photograph (if one is available) and to note whether the skull matches those features shown in the photograph.

By noting such pathological changes as old fractures, deformities, osteomyelitis, arthritis and tuberculosis, the investigator may gain additional clues to personal identification.

Summary:

Medico-legal study of the skeleton by the physical anthropologist gives valuable information concerning age, sex, stature and racial background of individuals, and assistance in their identification. In this paper some of the methods used are outlined.

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AN ANTHROPOLOGICAL VIEW OF DISEASE—Paleopathology of American Indians

A. COLE, 6T2

PALEOPATHOLOGY is the study of disease in prehistoric man. The material to be studied is of course limited to those parts of the body which have endured the ravages of time, i.e. the bony skeleton, although interesting additional material has been observed such as kidney stones and mummified bodies.

The value of this study is twofold, anthropological and pathological. On the one hand, the anthropologist, given information about a people's disease, can postulate or reinforce theories about their environment and how they have organized to cope with it; conversely, consideration of historic and prehistoric pathological material allows us to speculate on variations in course and incidence of disease processes, related to geographical and environmental factors.

Skeletal material, then, is examined for evidence of disease.

CONGENITAL CONDITIONS

These are deviations from the normal which are present from birth. Examples found in American Indian burial sites include fusion of vertebrae and phalanges, spina bifida, perforations in sternal body, variations in number of foramina and accessory bones of the skull.

ACQUIRED CONDITIONS

1. *Trauma*

The results of injury are common findings in bones of all primitive people. This is not surprising, considering the rigours of their existence. The form of the fractures is often quite specific in its indication of the causative injury. For example, if a Colles fracture is a sound basis for postulating a fall on the outstretched hand, then there should be even less doubt about the cause of a round hole in the hard palate, occupied by a flint arrow-head, such as was found at the Indian Knoll site. Some weapons produce characteristic damage and the presence of such damage (e.g. skull fracture produced by star-shaped mace) gives information on the homicidal activities of a people, whether in war or ritual sacrifice. Material from Ontario Iroquois in the Anthropology laboratory at the University of Toronto included many fractures of long bones and of the skull.

2. *Deficiency Diseases*

Of the deficiency diseases, rickets is rare, but not absent in anthropological material. This disease, an avitaminosis, is especially rare among the prehistoric New World Indians. Significantly, the rare instances of rickets among these people include specimens from the Indian Knoll dwellers, whose diet was grossly inadequate.

3. *Infection*

Changes indicative of suppurative osteomyelitis, including sinusitis and mastoiditis, are a common finding in American Indian bones and, indeed, in those of any prehistoric people. In the material from the Faherty site, there was a high incidence of severe manifestations, resulting often in gross deformity. This elicited comparison with modern material.

Robbins states that pyogenic osteomyelitis "is generally found in infants and children, but occasionally arises in adults." The incidence of adult osteomyelitis in the Faherty site bones was too high to be termed "occasional" and the degree of destruction in the Indian bones exceeded anything to be seen in the Pathology Museum. This not only demolishes the myth of the "healthy

savage", but demands explanation of the discrepancies.

Non-pyogenic osteomyelitis caused by tuberculosis is also seen. This affects long bones and particularly bodies of vertebrae. In both cases the change is predominantly one of destruction. In the vertebrae, collapse and fusion (Pott's disease) is common. These findings have definitely established the prehistoric existence of tuberculosis in the New World.

Syphilitic infection of bone because of its non-specific manifestations cannot be identified with certainty.

4. *New Growths*

Tumours are seen but rarely in prehistoric material. Interesting finds have been made, however, of multiple myeloma in New York State Iroquois by Ritchie (1932) and of meningioma in the Incas by Zariquiey (1958).

5. *Degenerations*

Degenerative changes of the skeleton are seen in osteoarthritis. Archeological remains indicate that this condition affected men as long ago as Neanderthal Man and has been a faithful companion ever since.

The osteoarthritic process is one of degeneration of articular cartilage, with subsequent proliferation of cartilage and bone producing characteristic lipping about the joint, concurrent with an atrophic change in underlying bone.

Arthritic lipping is the commonest abnormality found in pre-Columbian bones. The incidence and localization of arthritic changes agrees with modern findings.

It is generally acknowledged that aging involves osteoarthritic change and that osteoarthritic changes may or may not be accompanied by clinical findings. Investigation of bone aging has been carried out by Bohatirchuk (1957), who says that changes described as osteoarthritic include two different processes forming exostoses with different histological structure, one normal, the other abnormal. These two processes correspond fairly well in incidence with asymptomatic and symptomatic patients, hence, he postulates both a normal and a pathological process responsible for the changes. This controversial theory has been based on historadiographic evidence.

Summary

An outline has been given of the types of disease manifested in the skeleton with examples of findings in prehistoric North American Indian populations.

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The Department of Medical Biophysics announced a lecture given by Dr. E. C. Pollard, Head of the Department of Biophysics at Yale, on the "Use of Ionizing Radiation To Study Bacterial Structure". This lecture took place on February 4th at the Princess Margaret Hospital.

ANTHROPOLOGICAL STUDY OF VARIATION—A New View of the Scapula

J. D. GRAHAM, 6T3

THE scapula, chief bone of the shoulder girdle, articulates with the humerus and clavicle and gives attachment to most of the muscles that control the upper arm. This paper reviews some of its features that are of anthropological interest.

Examination of a series of scapulae provides an opportunity to observe the large degree of variation in size, shape and general appearance of this bone. It is of interest to the anthropologist to determine whether these variations are inherited or acquired and whether they are of value in determining the sex, age, or racial affinity of the subject.

THE VERTEBRAL BORDER

The medial, or vertebral border is variable in form. Graves in 1921 classified this border into three types: convex, straight, and concave. He noted that the convex type tended to be associated with a thicker vertebral border, a deeper, better developed glenoid fossa and a larger teres major impression. He attempted to link the occurence of concave border with individuals of poor physical condition and basically weak constitution.

Hrdlicka in an intensive review published in 1942, stated that in the fetus the vertebral border is invariably convex. This study also indicated that modern Whites have a lower incidence of convex border than do other peoples. He also noted sex differences in this trait. In the series studied, males tended to have ten per cent more convex and ten per cent fewer straight medial borders than do females.

The relationship of these findings to muscle influence was demonstrated by Wolffson in 1950 who conducted a series of experiments on rats. At birth he detached various muscles from the scapulae of various rats. The animals were sacrificed at 80 days and the form of scapulae studied. Cutting a muscle reduced the size of the scapula in every case. Changes in the vertebral border were noted when the rhomboids or serratus anterior were cut. The rhomboids influenced the border above the spine, and serratus anterior straightened the border below the spine. Interference with other muscle attachments resulted in similar alterations in the form of other parts of the scapula.

THE SUPERIOR BORDER

Similar variations may be noted in the form of the superior border. A deep, semilunar outline is generally present in the young, this being modified with age through muscle action to form a straighter border, generally of moderate slope.

The suprascapular notch may be absent, shallow, deep, or converted into a foramen. The notch shows a sequence of development with age. In the fetal bones of one study, the notch was totally absent. In older scapulae, the notch is present and appears to deepen with increasing age groups. In the skeleton of the elderly, a higher proportion of foramina are found than in younger groups. Formation of a foramen is presumed to be dependent on the ossification of the suprascapular ligament. Male scapulae have a greater incidence of deep notches and foramina than those of females.

VARIATION IN FORM

A few areas of variation in form have been briefly outlined above. Other variable features include the acromion shape, sulcus for the circumflex artery and costal facets.

Most of the studies that have been done suggest muscle action as the stimulus of variation. It would seem to follow that the observed sex and age differences in form are due to differences in strength of muscles and to the duration of their use. One observer has even attempted to relate occupation to the form and contour of the scapula. He has published pictures of the typical form of the scapula in sailors, farmers, carpenters, housewives and others. This is probably carrying the correlation a bit too far.

OSSIFICATION AND GROWTH

Ossification of the scapula begins from two primary centres. The centre for the body appears about the ninth fetal week. At birth, the acromion and coracoid processes are still cartilaginous. The centre for the coracoid process appears during the eleventh month. Phylogenetically, the coracoid is a separate bone and so has its own primary centre of ossification. After the tenth year, secondary centres appear successively: in the infracoracoid region, the acromion, the glenoid fossa, the coracoid and the inferior angle. The apophysis for the medial border is the last to appear, between the seventeenth and ninteenth year. Growth continues until about the age of 22 when all centres have fused. The timing of the appearance and fusion of secondary centres is a guide to age determination of the individual.

LATER OSSIFICATION

After maturity, additional ossification occurs generally all over the scapula, but especially around articular areas. The glenoid rim becomes lipped and the glenoid notch becomes filled in to a certain extent. Irregular arthritic lipping occurs around the clavicular facet of the acromion.

Ossification also occurs into the attachments of tendons, aponeuroses and ligaments. The most notable of these are the muscular cristae of the subscapular fossa, which at birth are non-existent, but become clearly marked with age. At the base of the spinous process is a triangular area where the rough attachment of trapezius becomes more prominent in older scapulae. Ossification of the supra-scapular ligament has already been noted.

INTERNAL CHANGES

Transillumination of the scapula allows observation of age changes in vascularity. Rich vascularity is seen in the adolescent scapula and this becomes more marked during the third decade, particularly in the central area. In middle age, the vessels become smaller and less distinct. With old age, many clear, pearly, rounded areas of atrophy develop. With increasing age, these atrophic spots increase in size and number and contrast sharply with localized thickenings such as the muscular cristae.

X-ray studies demonstrate changes in the architecture of the cancellous bone, which in adolescence is very fine and close-textured. In the third decade, a radiating pattern of trabeculae is organized from the glenoid fossa region. In middle age, the pattern becomes more open with the formation of lacunae. The parallel trabeculae become somewhat disorganized and buckling or distortion may be observed. In old age, these conditions are accentuated, and present a picture of general disorganization.

SEX DETERMINATION

Generally, the male scapula is larger in all respects than that of the female. A quantitative study was reported in 1956 by Bainbridge and Tarazaga who conducted a series of eleven measurements on a set of scapulae from English and Belgian cemeteries and anatomy departments. They calculated the mean for each sex in each measurement taken, and worked out the standard deviation

for each. Using these figures, they estimated the sex from a second series of scapulae unknown to them. In 131 specimens, only six errors in estimation of sex were made.

In 1958, the author used the Bainbridge system for sexing scapulae in a small representative sample from the cadaver collection in the Department of Anatomy of the University of Toronto. Of 34 scapulae, all were classified correctly except 4. It should be noted that the system is based on measurements of British and Belgian scapulae. Its value for medico-legal use here could be increased by setting up a standard from modern Canadian bones.

Summary

Variations in the form of the scapula may be related to muscle action. Age determination of the individual from the scapula may be made by study of its ossification, changes in vascularity and alterations in cancellous bone structure. The determination of sex from measurement of the scapula is accurate in a high percentage of cases.

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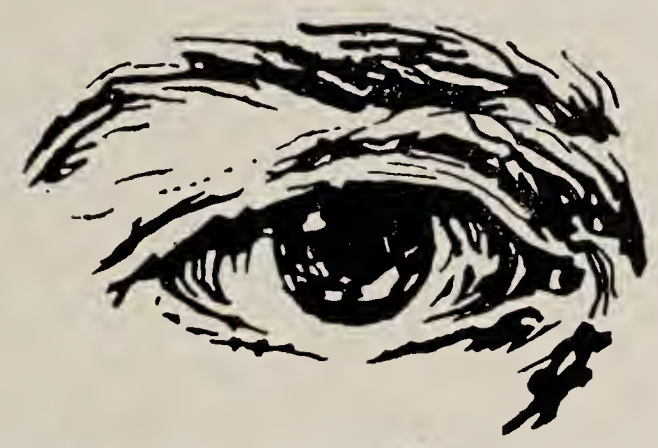

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Shelton, E.K.: J. Am. Geriatrics Soc. 2:632 (Oct.) 1954.

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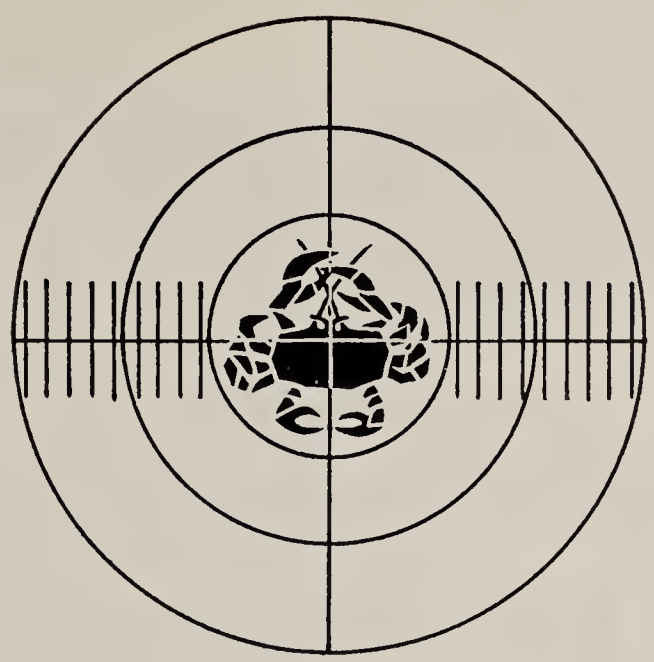

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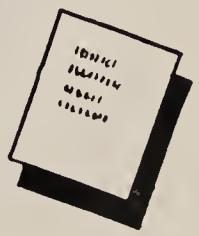

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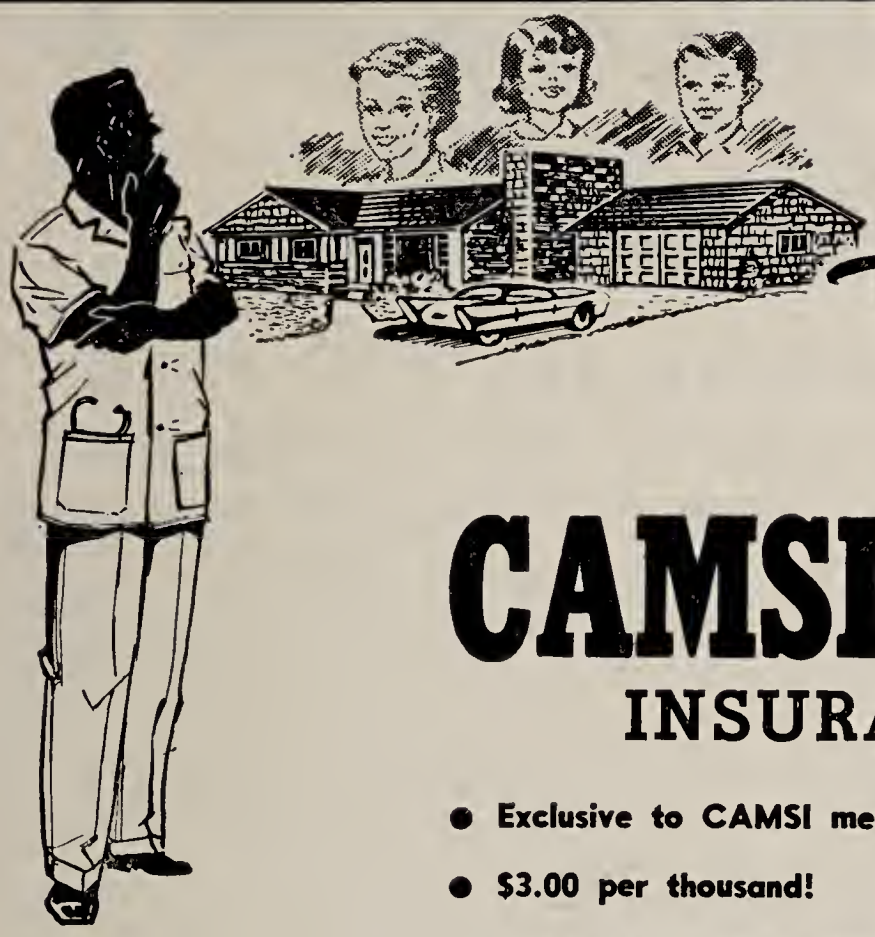

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